Dongleiwan deposit is a skarn type Cu-Mo-Au deposit in the northwest of Jiujia-Ruichang ore concentration area. This paper presents the fluid inclusion petrology, microthermometric data and gas-liquid chromatographic analytic results as well as hydrogen, oxygen and sulfur isotopes analytical results in an attempt to constrain the property of the ore-forming fluid and discuss ore-forming material source and mineralization mechanism.

1 Deposit Geology

The tectonic position of the Dongleiwan deposit is located in the northern margin of the Yangtze Block. The deposit belongs to the Jiujia-Ruichang Cu-Au ore field and is one of the important parts of the Daye-Jiujiang metallogenic sub-belt of the middle-lower Yangtze River metallogenic belt. The exposed formations include the Permian Changxing Group (P2c), Triassic Daye Group (T1d), and Jialingjiang Group (T2j) as well as the Quaternary. The northern part of the deposit is the Miaomushan Anticline while the center is the Dongleiwan Syncline. There are seven relatively large fracture belts within the area in which mineralization is very common. The Dongleiwan intrusion is a composite one related to the mineralization, with the granodiorite in the center, quartz-diorite-porphyry in the margin and coarse-grained granodiorite-porphyry in the middle.

The deposit could be divided into two ore belts. The north ore belt is located in the north limb of the syncline with widely distributed chalcopyrite and pyrite mineralization. The south ore belt is located in the south limb of the syncline. Disseminated pyrite and malachite can be observed locally. The structures of the ores include massive and disseminated structures while the ore textures are mainly hypidiomorphic-granular texture and metasomatic relict texture. The main metal minerals of ores are chalcopyrite, pyrite, bornite, molybdenite, scheelite as well as minor sphalerite and bismuthinite while gangue minerals include garnet, quartz, chlorite, diopside, calcite, and fluorite. Wall rock alterations consist of skarnization, chloritization, epidotization and carbonatation. The skarnization is the most common one and also closely related with mineralization. The ore-forming process can be divided into four stages: (1) skarnization stage in which garnet, diopside and other anhydrous silicates were formed; (2) retrograde alteration stage in which phlogopite, epidote, chlorite and tremolite and magnetite were formed; (3) quartz sulfide stage which is the most important stage for mineralization of copper and molybdenum within this deposit; and (4) carbonate stage in which the main composition is calcite, pyrite and chlorite.

2 Analytical Results

The primary inclusion at the main mineralization stage can be divided into four categories: (I) gas-liquid inclusion, (II) daughter material bearing multiphase inclusion, (III) CO2-bearing aqueous solution inclusion, and (IV) CO2-rich inclusion. In I category, the range of the homogenization temperature is the biggest, varying from 131°C to 359°C. The freezing temperature is from -19.7°C to -0.2°C and the corresponding salinity $\omega$(NaCleq) varies from 0.4% to 22.2%. The density ranges from 0.63g/cm³ to 1.08g/cm³ while the trap pressure is between 1.28 to 180.01 MPa. In II category, only two fluid inclusion were
observed. The homogenization temperatures are 295°C and 304°C, respectively. During temperature-rising period, the daughter-materials did not change and they also did not disappear until the inclusions burst, indicating that they are not the real daughter-minerals, but rather crystals wrapped in inclusions during the formation of these inclusions. In III category, the initial soluble temperature of CO₂ is from -57.7°C to -56.6°C. The fusion temperature of CO₂ clathrate hydrate is from 7.6°C to 9.8°C, with the peak value from 8°C to 9°C. The partial homogenization temperature of CO₂ varies from 7.3°C to 31.3°C and the complete homogenization temperature is from 211°C to 327°C. The salinity $\omega$(NaCl(1eq)) is from 0.4% to 4.7% while the density is from 0.25 g/cm³ to 0.87 g/cm³. In IV category, only two inclusions were observed. The initial soluble temperatures of CO₂ of these inclusions are -61.7°C and -57.4°C, respectively. The fusion temperatures of CO₂ clathrate hydrates are 8.5°C and 8.6°C. Both of the partial homogenization temperature of CO₂ inclusions are 31.3°C and complete homogenization temperatures are 347°C and 369°C, respectively. The salinity $\omega$(NaCl(1eq)) varies from 2.8% to 3.0%, with density ranging from 0.44g/cm³ to 0.48g/cm³.

$\delta^{18}$O$_{V-SDMO}$ values of four quartz samples range from 12.4% to 16.0‰ while the $\delta$D$_{V-SDMO}$ values vary from -81‰ to -64‰. The oxygen isotope of the water in equilibrium with quartz is calculated according to $1000ln_{quartz - water}$ = 3.34×10$^6$×$T^{-2.90}$ (Matsobisa, 1979). The calculated $\delta^{18}$O$_{H_2O}$ values of fluid is from 0.93‰ to 5.20‰.

$\delta^{34}$S values of six sulfide samples are near 0, with the variation range varying from -2.2‰ to 3.4‰ and an average of 0.4‰, which have the larger variation than the average of mantle (0‰ ~+1‰, Kyser, 1986), suggesting the significant characteristics of mixed sulfur isotope.

3 Discussion and Conclusion

With homogenization temperature changing from 210°C to 350°C, salinity $\omega$(NaCl(1eq)) varying from 1% to 9%, and the density ranging from 0.3g/cm³ to 1.0g/cm³, the ore-forming fluid of this deposit should be ascribed as the middle-high temperature, low-middle salinity system.

In the $\delta$D-$\delta^{18}$O$_{H_2O}$ diagram, all the samples are plotted in the right side of global meteoric water line and close to the magmatic water area, far away from metamorphic water area, indicating that the ore-forming fluid mainly derived from the magmatic water.

Due of $d^{34}$S values deviating from, it is inferred that S mainly derived from the upper mantle in Jiujiang-Ruichang ore concentration area but was contaminated by crustal materials, especially the cupriferous pyrite deposit during the ascending process (Ji et al., 1990). Wei et al. (2001) suggested that Pb isotopic compositions of the Dengjiashan and Dongleiwan deposits also reflected a mixing between the mantle material and crust material.

In Dongleiwan mining area, the ore-bearing magma rich in Cu, Cr, Co, Ni and other basic compatible elements induced by the deep crust-mantle interaction ascended along the deep fracture, experiencing crust assimilations and multiple differentiations. The ore-bearing fluid from the magma reacted with the wall rock to form skarn under the relatively stable chemical environment. Due to ongoing interaction between the ore-bearing fluid and wall rock and certain amount involvement of meteoric water, the temperature of ore-forming fluid decreased gradually. When the temperature fell within the range of the quartz-sulfide mineralization stage, the solubility of metal ions decreased rapidly and large amount of sulfides precipitated, forming this ore deposit.

References


